Improving the management of this information through a health care information infrastructure will enable efficiency gains and cost savings throughout the entire health care process.

ment of and access to health care-related information and to reduce costs for processing insurance claims through electronic payment and reimbursement. Second, better access to medical data and patient medical histories will help improve doctors' diagnoses by providing fast and easy access to accurate, complete, and up-to-date information. Third, high speed networks will enable residents of rural areas and inner cities to enjoy the benefits of the latest medical technologies and expert opinions without leaving their home towns. Finally, easy access to information by individuals in their homes on self-care and healthy lifestyle practices will enable people to better manage their own health, reducing the number of visits to doctors' offices and hospitals, and increasing the likelihood that medical problems will be identified earlier.

The challenge is to create a medical information infrastructure that will support the following types of applications that could help, in the near and longer term, to solve the health care problems the nation is experiencing:

■ **On-Line Patient Records** — Hospitals, doctors' offices, and community clinics will be interconnected through high speed networks. Patient records, including medical and biological data, would be available to authorized health care professionals anytime, anywhere (with privacy assured) over these networks. This would enable health care providers to access immediately, from any location, the most up-to-date patient data, including medical images from tests, resulting in improved diagnoses and more informed treatment decisions.

■ **Medical Collaboration** — Medical personnel will use interactive, multimedia telemedicine technologies to collaborate and consult with each other over distances. Doctors in hospitals or offices will consult on short notice with experts located anywhere in the nation; emergency room physicians will provide vital assistance to emergency medical personnel on the scene via wireless technologies. Patients and their doctors would have instant access — at affordable cost — to experts and specialists, no matter where the patient is located.

■ **Surgical Planning and Treatment** — Physicians and surgeons will use high speed computing technologies to simulate the function of human organs to facilitate medical diagnoses and treatment decisions, and to plan complex surgical procedures. Imaging and modeling techniques will be used to produce realistic and detailed 3D models of a patient's organ, to develop the most effective and safe surgical procedures, to demonstrate planned procedures to patients and medical students, and to develop alternate non-invasive treatments. With high speed networks, images could be transmitted instantly to experts located elsewhere for confirmation of diagnoses and treatment recommendations.

Education

To ensure a secure and prosperous future, Americans need to be able to think critically and to have access to the widest possible body of knowledge. The work force requirements of the future will increasingly require people to be able to learn new skills to adapt to changing job requirements and new technologies and to use knowledge and information to make decisions. Changes must be made to the United States' education system to ensure that it will give individuals the skills they will need for lifelong learning in a high wage, information-based economy of the future.

Meeting these challenges will require extending America's edge in computing and communications technologies to education services in schools, communities, work places, and homes. An information infrastructure for lifelong learning will offer unprecedented potential for improving lives by making knowledge readily available and usable by all Americans. Such an infrastructure would provide a tool for addressing many of the learning needs the country is facing, including, for example, making additional resources available on-line for teachers who want to improve their skills and update their knowledge; providing a means for Americans to continually acquire the new knowledge to adapt to the multiple careers many will likely undertake; providing seniors and disabled or homebound Americans direct access to information resources critical to their health and welfare; and providing better access to information that affects our quality of life and cultural awareness.

Effective deployment of a computing and communications infrastructure for education and lifelong learning requires well trained and technologically experienced teachers and administrators

An information infrastructure for lifelong learning will offer unprecedented potential for improving lives by making knowledge readily available and usable by all Americans.

who can facilitate the use, installation, and management of new instructional technologies such as digital interactive video, local area networks, and gateways to national networks. Users and students will need new skills to help them retrieve, review, categorize, and analyze the information and knowledge they will be able to access. This will require investment in training for educators and students in the use of new technologies, development of model curricula and new instructional techniques, development of new information resources, improvement in the quality of existing resources, and extension of public access to electronic schools and libraries.

A national information infrastructure will create an enormous range of education and lifelong learning applications, such as:

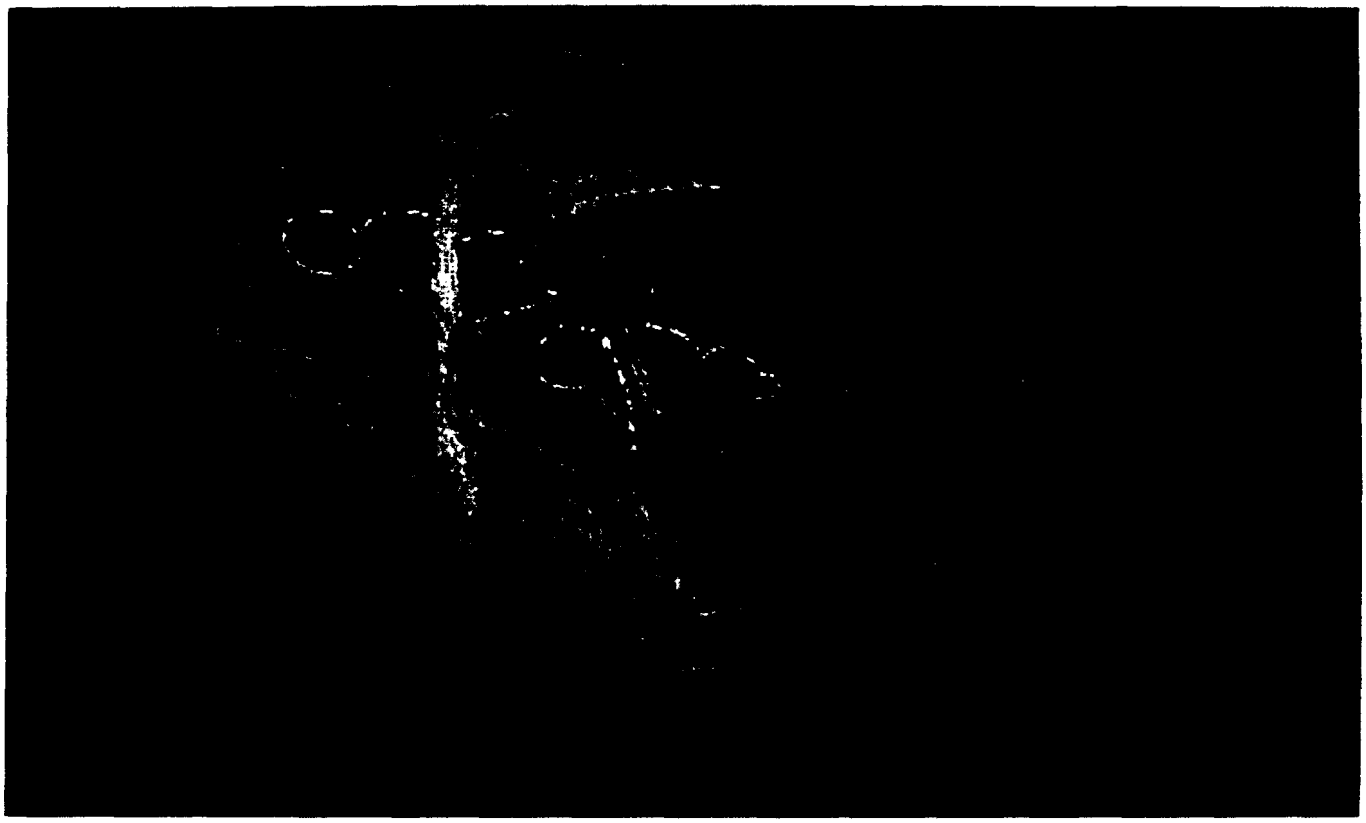
■ **On-line Job Training Libraries** — Interactive, multimedia, digital libraries will be available on job sites to provide workers with task-oriented information that they could use, at their own convenience and pace, to improve and upgrade their job skills and performance. Workers in any job — assembly lines, retail outlets, sales, or offices — would be able to continuously upgrade their skills and learn new skills at any time through customized training libraries.

■ **Electronic Libraries** — Students will use on-line electronic libraries in classrooms and at home to learn more about any topic. For example, if a student wanted to learn about the works of Shakespeare — or about a specific play — he or she will simply turn on a computer and, with the flick of a switch, be connected to the entire works of Shakespeare, complete with photographs, videos, and recordings. The electronic libraries will include software tools to help students find the information they need, identify relevant data, analyze, and present the information and will provide access to information and reference specialists to help users locate the material they need.

■ **Virtual Laboratories & Field Trips** — Through virtual laboratories, students will perform science experiments using equipment and facilities located anywhere in the United States, including at the national laboratories, in collaboration with some of the nation's best laboratory scientists. Students will also take "field trips" to museums, observatories, science exhibits, and research centers without leaving the classroom.

■ **Collaborative Learning** — Students of all levels and ages, teachers, and experts will collaborate, in real time, via high speed networks, on a wide variety of learning projects. The collaborators will access information and high performance computing resources located throughout the country, such as images collected by NASA's Earth Observing System satellites, and would work together to develop research projects that focus on their own interests.

Intelligent Manufacturing



The U.S. manufacturing enterprise faces enormous challenges over the next decade just to keep up with new information and new technologies. The industrial world is rapidly moving to "electronic commerce," in which suppliers and design collaborators will be on-line; factories will be highly programmable and staffed with highly skilled personnel; product design and manufacturing will be fully integrated; and custom-made, high-quality products will be manufactured rapidly in small quantities. Failure to keep pace and maintain technological leadership will threaten our long-term competitive position in the world market.

Increasingly, to stay competitive, companies of all sizes must be able to respond rapidly to customer demands for high-quality products at low cost. This requires manufacturing and design processes that are highly efficient and flexible to enable the shortest possible design, development, and production times. Companies able to adapt and apply the latest information and communications technologies to their manufacturing processes will have an advantage over their less innovative competitors in the future. The challenge, therefore, is to develop, deploy and apply the technologies for a manufacturing infrastructure that incorporates computing and communications technologies to support integrated development, engineering, and manufacturing processes.

It is critical to ensure that small and medium manufacturers are stakeholders in this new infrastructure. Small and medium manufacturers are vital to the nation's economic development and growth, accounting for 40 percent of GNP, half of all employment, and more than half of job creation. Providing small and medium companies with access to computing, communications, and

information resources will enable them to adopt new technologies and manufacturing techniques, reducing the cost of doing business and increasing efficiency and productivity.

Work is already underway in the private and public sectors to expand the use of advanced computing and communications technologies in the manufacturing process, but much more is needed. HPCC Program research in aerospace vehicle design and advanced materials are just a few examples of the application of high performance computing to benefit our industries. Computer-aided design (CAD) and computer-aided manufacturing (CAM) technologies are being incorporated into U.S. manufacturing enterprises at increasing rates. However, CAD/CAM technologies, which are further advanced than many other intelligent manufacturing innovations, still need improvement before they can be widely implemented and must be integrated into both the design and manufacturing processes to fully realize their benefits.

A national information infrastructure has the potential to significantly increase the productivity and quality of U.S. manufacturing by enabling applications such as:

■ **Concurrent and Distributed Design, Engineering, and Manufacturing** — Manufacturers of products, from automobiles to airplanes, and from machine tools to televisions, will distribute scheduling and production across geographically dispersed facilities to reduce production delays, minimize manufacturing, transportation, and inventory costs, perform design, engineering, and manufacturing concurrently, and leverage unique skills and availability of skilled resources. Large amounts of information, such as engineering modeling data, product specifications, test specifications, and bills of materials, will be distributed and shared among dispersed facilities in real time. All of these techniques will significantly reduce the time to develop new products and bring them to market.

Companies able to adapt and apply the latest information and communications technologies to their manufacturing processes will have an advantage over their less innovative competitors in the future.

■ **Electronic Commerce for Manufacturing Enterprises** — Companies of all sizes will increase their efficiency and productivity while reducing costs by incorporating electronic commerce into their operations. Through links with suppliers, customers and local, state and federal governments, companies will be able to conduct virtually all of their essential business opportunities electronically, including: locating the best suppliers to meet their needs, identifying potential customers for their products, placing and receiving orders, exchanging payments, and ascertaining the latest government regulations affecting their businesses and submitting required compliance reports electronically.

■ **Virtual Design and Manufacturing Project** — Manufacturers of complex, expensive products will use virtual design facilities to model, simulate, and visualize product designs and manufacturing processes in advance, saving the costs of building prototypes. Eventually, virtual reality technologies will permit product designers to "walk through" new products before actually building the products and through manufacturing facilities before production begins.

By investing in the HPCC Program, the United States has already begun investing in the research for an infrastructure based on high speed networks, high performance computers, and on-line information. CSPP will continue to work with Congress and the new Administration to implement our recommendations to improve the structure of the HPCC Program. However, we must now make a national commitment to take the next step to develop a new national information infrastructure that will provide us with the best opportunity to compete in the global economy of the future.

Through a public and private partnership to develop and deploy a national information infrastructure, we will not only lay the best foundation for remaining internationally competitive, we will also give ourselves the best chance to solve many of our domestic challenges — the declining quality of education, the skyrocketing cost and limited availability of high-quality health care, and the need for businesses of all sizes to increase quality and productivity — which increasingly require the ability to access and use large amounts of distributed information.

We must now make a national commitment to take the next step to develop a new national information infrastructure that will provide us with the best opportunity to compete in the global economy of the future.

The time to act is now. Creating a national information infrastructure of the future will require improving upon and linking together current communications, computing, information, and human resource capabilities. More importantly, it will require developing new capabilities to enable broad access by millions of Americans to public and private information resources and to enable people to generate, transmit and receive text, images, and video anywhere, at any time.

Before the comprehensive information infrastructure of the future can be realized, a broad cross-section of American industries, academic and research institutions, and the federal government need to agree on a common vision for the effort. With a common vision in place, the private and public sectors can make a commitment to do what they need to do, independently or together, to make the vision a reality. While the private sector has primary responsibility for developing and making available the services, products, networks, and applications to make the infrastructure possible, the federal government has an important role as a catalyst in stimulating the effort and creating a regulatory environment that will encourage private sector investment and implementation.

To accelerate the development and deployment of a national information infrastructure, CSPP recommends that the Administration, Congress, and the private sector begin a joint effort to take the following actions:

Administration Agenda

1. Make the NII a National Technology Challenge: The President should declare the national information infrastructure a new national technology challenge. The President should, in his State of the Union address and his FY94 budget submission, issue a challenge to Congress, industry, academic, and research institutions, and potential users to work with him to create a new information infrastructure.

2. Establish a National Information Infrastructure Council: The successful development and deployment of a national information infrastructure will be contingent upon the government adopting a vision and a strategy for its implementation. The best way to accomplish these objectives is to establish a National Information Infrastructure Council, chaired by the Vice President, to provide a management focus for the effort. Members of the Council should include the Secretary of Commerce, the Director of the Office of

Science and Technology Policy, the Chairman of the Federal Communications Commission, and the heads of other federal departments, agencies, and White House Executive Offices who have roles or responsibilities in the information infrastructure, and private sector experts, including representatives of industry, user groups, and research institutions. The Council should have as its initial responsibilities:

- adopting a vision for an NII;
- working with the private sector to develop and adopt several concrete goals for the NII, with accomplishable milestones;
- coordinating the NII activities of the various government agencies and departments; and
- developing a strategy to address the information infrastructure policy principles listed following these recommendations.

3. Establish an NII Implementation Entity: Establish a federal entity to implement the National Information Infrastructure Council's vision, plans, strategies, recommendations, and other directions. The entity should have the responsibility and the authority to:

- manage and focus the NII research agenda, including research performed by the national labs;
- coordinate, in conjunction with other appropriate agencies and departments, the NII technology demonstrations; and
- develop strategies to overcome policy and regulatory barriers affecting the deployment by the private sector of a national communications network of interoperable, interworking networks.

4. Invest in Research for an NII: The FY94 budget request should include funds for precompetitive, generic research on enabling technologies for an NII, such as the following:

- research on the generic, enabling technologies needed to address challenges in health care, education and lifelong learning, and intelligent manufacturing;
- research on the scalability problems associated with aggregating many high, medium, and low speed users;
- technologies and architectures to ensure the security of information available in an NII and to guarantee privacy of information;
- interoperability;
- integrity and robustness of networks and databases;
- human/computer interfaces, such as speech and handwriting recognition and machine intelligence; and
- research on creating and managing distributed electronic databases and libraries, such as indexing databases, digitizing libraries, and organizing material.

5. Fund Pilot Projects to Demonstrate Technologies: In conjunction with industry, the federal government should fund pilot projects to demonstrate the application of high performance computing and communications technologies to health care, education and lifelong learning, and manufacturing. Such projects will help solve problems in scaling technologies and accelerate development of standards.

6. Develop a Public Education Program: Request the National Research Council of the National Academies of Science and Engineering to develop, in conjunction with the private sector, a program to educate the general public about the potential benefits of an NII and the impact it will have on their lives.

7. Make Government Information Easily Accessible: An information infrastructure could provide federal, state, and local governments with a system to better serve their citizens while reducing the cost of providing those services. Through a national information infrastructure, people would have ready access to the most up to date information about their entitlement to health, education, housing, and social security benefits. Citizens could, for example, use the infrastructure to register to vote, renew their drivers licenses, and pay their taxes. The National Research Council should assess federal information collection and dissemination policies and practices and make recommendations on how such policies and practices should be changed to make public information easily available and accessible to citizens through the NII. The NII implementation agency should be charged with developing a strategy to implement the recommendations across all affected departments and agencies

Legislative Agenda

1. Authorize a National Information Infrastructure Council and Appropriate Funds for its Operation: Introduce legislation to authorize creation of a National Information Infrastructure Council to oversee development of the NII and appropriate funds for its operation.

2. Authorize and Appropriate Funds for Research and Technology Demonstrations: Introduce legislation, based on the Information Infrastructure and Technology Act of 1992, to authorize research on NII technologies and demonstration projects in health care, education, and manufacturing, and appropriate funds for such projects.

Industry Agenda

1. Continue Investments to Develop and Deploy an NII: The U.S. computer industry is investing billions of dollars each year in research and development relevant to an NII. Industry must continue to work to develop and deploy the NII, including:

- deployment of interoperable communications networks;
- development of on-line databases and applications;
- development of easy to use computers and information appliances; and
- training people to design, develop, and use the various elements of the infrastructure.

2. Continue to Invest in Research and Development of Applications: Companies must continue independent and collaborative efforts to invest in research on NII technologies and development of new products and services.

3. Reach Out to Other Industries: CSPP will initiate a project to encourage other industries likely to benefit from the applications made possible through an NII to join the effort to achieve an NII.

4. Promote NII Efforts: A wide range of affected industries should form a non-profit group to work with the National Research Council to promote the NII.

5. Develop and Participate in Pilot Projects: Industry should undertake an effort to develop strategic plans and facilitate the formation of teams to design technology demonstration projects in health care, education and lifelong learning, and manufacturing.

6. Develop NII Goals and Milestones: The private sector will work with the Infrastructure Council to develop specific examples of accomplishable goals for an NII, with concrete milestones, such as, for example, a nationwide system of on-line patient records accessible by any authorized health care professional, anywhere; and all small and medium manufacturing companies networked with the manufacturing extension centers.

Policy Principles for a National Information Infrastructure

The public and private sectors have important roles in making the information infrastructure a reality. While the development and deployment of the infrastructure must be led by the private sector, guided by the forces of a free and open market, the federal government can accelerate its implementation by acting as a catalyst and a coordinator.

CSPP has identified the following important public policy principles that will have to be addressed jointly by the public and private sectors before the information infrastructure can become a reality. CSPP looks forward to working with the new Administration, new Congress, and other industry groups to address these issues.

1. **Access** -- Because an informed citizenry is essential to the nation's growth, all individuals must have access to the NII.

2. **First Amendment** -- To ensure freedom of expression in an NII, First Amendment principles guaranteeing freedom of speech, as articulated by U.S. courts, should apply to electronically-transmitted communications.

3. **Privacy** -- Consumers of NII services have a right to privacy in their use of the NII.

4. **Security** -- Information available through the NII must be protected against unauthorized access, tampering, and misuse, consistent with the needs of the applications and the desires of the user.

5. **Confidentiality** -- NII users must be free to use effective, industry-developed encryption to ensure confidentiality of communications and data.

6. **Affordability** -- To promote maximum use, the NII must be affordable.

7. **Intellectual Property** -- The fundamental principles of copyright should apply to electronically-available information in the same manner as for other media.

8. **New Technologies** -- While it is impossible to anticipate all of the technologies that will eventually be part of the NII, the political and regulatory environment must encourage the development of new technologies and their incorporation in the NII.

9. **Interoperability** -- The NII must support maximum interoperability among networks in this country and internationally.

10. **Competition** -- Service providers must have fair and open access to the NII in order to assure competition among such providers.

11. **Carrier Liability** -- Information services carriers and distributors who have no editorial control over the contents of electronic information should not be liable for the content of the information transmitted over the NII.